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THE NEW ENGLAND BOTANICAL CLUB

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FLORAL CHANGES IN A SALT MARSH DURING RECLAMATION.

Walter Deane.

In 1908 a dam was constructed across Charles River near its mouth between Boston and Cambridge, Massachusetts. The object was to raise the water in the Basin above to a permanent level for civic improvement. The exclusion of salt water and tidal action, which followed this work, at once began to bring about the inevitable changes in the flora of the salt marshes along the banks of the river that had been within reach of the tides. For several years I have been much interested in studying these changes in a certain piece of marsh in Cambridge not far from my home.

I have collected specimens of every species of plant not including the lower cryptogams that I could find on many visits to the given area, and I feel confident that little, if anything, has escaped me. Of course a collection of this sort can never be complete, as additional species will doubtless come in every season, as long as the marsh is undisturbed. As the given area is under the control of the Metropolitan Park Commission, the land may be developed at any time, and it seems best to record now the result of my observations.

Before the building of the dam in question the tidal limits of Charles River were at a dam in Watertown, about eight miles above the new one, which is near the mouth of the river. Until the change was made the section of marsh under consideration was subjected to the usual tidal action. It was covered at the regular seasons by the high tides, and its surface was cut by innumerable ditches dug in the early days to drain the marsh. Except for the changes resulting

from the exclusion of the salt water and tidal wash, it is practically the same to-day as of old, the fact which affords its chief biological interest, most of the salt marsh bordering the river having been transformed for park, building and other purposes.

The marsh is on the left or west bank of the river and is well defined. It has approximately the form of a segment of a circle, the chord or straight side running north and south, directly east of Cambridge Cemetery and close to it, a bank some 20 or 25 feet high descending from the Cemetery to the marsh. This bank extends from the south end for some two-thirds of the distance, the remaining portion of the marsh being bordered by land several feet above the marsh and by a hill. The eastern portion of the marsh, forming the arc, borders on the river. The greatest length of the area is 2250 feet, or a little less than half a mile, while the greatest width is 800 feet or about one sixth of a mile.

It was in the fall of 1908 that the river was closed. To quote from the Sixth Annual Report of the Charles River Basin Commission, published December 1, 1908, "On Oct. 20, 1908, the eighty-two gates in the shut-off dam, described in the Commission's last report, were closed simultaneously. * * * * The Basin in the beginning had to be filled for the most part with salt water, the long drought having reduced the daily flow of the Charles River to so small an amount that to fill it with fresh water would have taken many days, whereas it was possible to fill the Basin in a few hours with water let in through the sluices. The permanent water level, established soon after the closing of the shut-off, is at the grade of 8 feet above Boston Base, and Boston Base is 0.64 of a foot below mean low-water mark. * * * * Seventeen and one-half miles of shore line have undergone a transformation which will render their further improvement a matter of small expense compared to the cost of their treatment." And again, "On the morning of October 20, forty-one men with axes were assigned to their stations on the frame from which the gates were suspended, and each man was instructed on a given signal to cut the ropes that held two gates, after which he was to come down, fasten the gates in place with wedges and see that each gate was completely closed. At 11 A. M. the signal was given and in two seconds all of the gates were down; in two minutes they were all wedged securely in place. * * * * A large plant immediately began the work of placing earth fill next the shut-off dam. Within a week the fill was well up to ordinary high

water, and before the next run of high tides the fill was made nearly complete. There has been no appreciable movement of the structure since the filling has been in progress."

Mr. Hiram Allen Miller, consulting engineer for the Commission, writes under date of June 5, 1913, "The permanent level of the Basin is at grade 8 and it rarely ever varies 2 or 3 inches above or below that elevation. There is no appreciable current in the year below the arsenal, except in case of heavy floods." The arsenal is at North Beacon Bridge referred to later. Mr. George Lyman Rogers, Secretary of the Commission, writes under date of May 16, 1913, "In answer to your inquiry relative to the freshness of the water in Charles River Basin opposite Cambridge Cemetery, I would say that an average of fifteen analyses made of the water in the Basin at Western Avenue Bridge in 1912 showed 32 parts chlorine in every 100,000 on the surface, and on the bottom 54 parts chlorine to 100,000. This is practically fresh water. The analyses at North Beacon Bridge made even a better showing," and Mr. John R. Rablin, engineer of the Commission, writes me on June 5, 1915, "The following table from the chemical examination of water in the Charles River Basin, taken at West Boston and North Beacon Street bridges in 1914, shows the number of parts in 100,000 of chlorine:

West Boston Bridge,	Surface, July,	35.00;	Oct. 174.00
" " "	Bottom, "	65.50	" 168.00
North Beacon St. Bridge,	Surface, "	1.60	" 140.00
" " " "	Bottom, "	1.50	" 143.00."

In regard to the discrepancy between these figures and those given me by Mr. Rogers, Mr. Rablin writes on June 22, 1915, "In reply to your inquiries of June 18, I would say that the information in regard to chlorine in the water of the Charles River Basin was probably from analyses taken at different seasons of the year, and if you could examine the records of all analyses you would find that the quantity varies from practically nothing in the spring to from 100 to 200 parts in 100,000 in the fall. This variation is due to the fact that the fresh water flow of the river during the winter flushes out the river and keeps it fresh until such time as the lack of fresh water from above allows the amount of salt water to increase." In the same letter he writes, "The salt water entering the Basin from the operation of the locks, being much heavier than the fresh water, is likely to affect

the water of practically the whole Basin, especially in dry seasons, but remains at the bottom of the river."

The center of the marsh in question is about 4.8 miles above the dam, 1.5 miles above Western Avenue Bridge, and 1.75 miles below North Beacon Bridge. West Boston Bridge is nearly half a mile above the dam. The surface of the marsh is from 3 to 5 feet above the level of the water, and is easily traversed. Innumerable ditches run east and west, some still open, others more or less closed, while still others are visible only by a slight depression on the surface. A ditch, interrupted here and there, skirts the western border of the marsh, while at the southern extremity an additional ditch extends northward for about one third of the length of the marsh.

It seems clear from the above that no accession of salt water can now affect the marsh in question, owing to the permanent elevation of the surface above the river whose waters are pronounced practically fresh. The retention of the salt still in the soil seems the determining factor governing the length of time that the true salt marsh plants can subsist.

Before the closing of the river the flora of the marsh was typical of that of any similar area. Reference to my journals and herbarium shows that *Juncus Gerardi* Loisel. was the principal growth in 1884. *Triglochin maritima* L., *Puccinellia maritima* (Huds.) Parl. and *Potentilla pacifica* Howell were abundant. From this locality I also find in my herbarium *Scirpus campestris* Britton, var. *paludosus* (A. Nelson) Fernald, *Atriplex patula* L., var. *hastata* (L.) Gray, *Ranunculus Cymbalaria* Pursh, *Gerardia maritima* Raf., *Solidago sempervirens* L. and others, collected between 1884 and 1895. These were taken on desultory visits and they represent only a few salt marsh plants, but as the specimens exist, they are worth recording.

My recent visits to the marsh began in 1912 and have continued to the present time, though the principal work was done in 1912 and 1913, covering the six months from May 1 to October 30. Thirty-one visits have been made, exclusive of some walks over the marsh when snow and ice covered it.

I was first struck by the immense number of plants, both native and introduced, that had invaded the area from the neighboring uplands and made a strange contrast with the plants growing there naturally. It seemed like the invasion of an army into a territory apparently little suited as a home for them, but they had evidently

come to stay, if their flourishing condition was any indication. The vigorous growth of these incoming plants was especially noticeable and will be referred to in the list. After making several visits I was more and more interested in this strange admixture. There was no special association into colonies. *Juncus Gerardi* Loisel. covered still a large part of the area, but scattered here and there amongst it were *Taraxacum officinale* Weber, *Echinochloa crusgalli* (L.) Beauv., *E. muricata* (Michx.) Fernald, *Agrostis alba* L., and varieties *vulgaris* (With.) Thurber, and *maritima* (Lam.) G. F. W. Mey. and hosts of other species, while *Linaria canadensis* (L.) Dumont had taken entire possession of considerable areas. *Erechtites hieracifolia* (L.) Raf. and *Lactuca scariola* L., var. *integrata* Gren. & Godr. are other examples of plants occupying almost exclusively a soil seemingly quite unfitted for them.

As this sketch is written with a view to making merely an annotated list of the species found, I will not add here more than a few examples by way of giving a general idea of the mixed condition. Along the creeks mingled with *Spartina glabra* Muhl., var. *alterniflora* (Loisel.) Merr. was *Ranunculus sceleratus* L., while *Cerastium vulgatum* L. showed a most vigorous growth, entirely surrounded by true salt marsh species. Salt marsh and fresh water plants grew side by side along the creeks, *Acnida cannabina* L. with *Sagittaria latifolia* Willd. and its forms, while both in the creeks and in the river itself grew *Typha latifolia* L.

With this brief account of the general conditions of the marsh, I will enumerate in order, with notes, the various plants observed and collected. I have carefully defined as the western limits the line separating the upland from the marsh itself. In some places dumps occur projecting a little into the marsh. These, as well as doubtful spots, have been rejected in considering the flora. Every plant, taken into consideration, grew on the area that was a true salt marsh before the salt water was shut off, and that is still unchanged in grade.

The reclamation of saline areas by diking or through the damming of tidal inlets has of course been of frequent occurrence in many countries, notably in Holland, yet in the botanical literature readily available it has been impossible to discover any detailed accounts of natural readjustments in the flora of such areas. This is presumably due to the fact that such tracts, which are commonly reclaimed at very considerable expense, are apt to be put to pretty prompt economic

use for agriculture, grazing, or building purposes quite subversive of the gradual biological changes here traced. However, the ecological aspects of the vegetation on considerable areas of a more or less similar nature are discussed in detail by Prof. W. F. Ganong in his highly interesting paper "The Vegetation of the Bay of Fundy Salt and Diked Marshes, an Ecological Study"[1] to which is appended a careful bibliography of the general subject.

Flora of the Marsh.

Ceratodon purpureus Brid. Abundant in open spots near the center of the marsh.

Polytrichum commune L. Abundant along the river border in muddy, wet soil, close to the water.

Pottia truncata Br. & Sch. Abundant along the river border in muddy, wet soil, close to the water.

Typha latifolia L. The Cat-tail occurs abundantly and fruits freely. It is scattered along the river border a few feet from the shore, especially at the north end, and it is common in ditches on the west side.

Potamogeton epihydrus Raf. A patch several feet across was on the river border on July 17, 1912.

Potamogeton bupleuroides Fernald. Plants with leaves only were found in the river near the shore in the cove at the south end on August 16, 1912, and September 12, 1913.

Potamogeton crispus L. Very abundant along the shore and in ditches. A resumé of my notes made from many visits during the season may be of interest. According to my observations the species behaves in the following manner. In early May *P. crispus* appears in great abundance. An examination of the plants shows that they are the old last year's stems with fresh young shoots starting from them. I wrote on May 1, 1913, "Old plants of last year very abundant, in dense masses, along the river border, sending out fresh shoots." On May 20, 1913, I made another record, "Is in full flower, the spikes projecting above the water by thousands. Masses are along the shore and in the mouths of the larger creeks, the fresh stigmas and anthers presenting a beautiful appearance under the glass. I pulled up several plants and it seems that they must be the very ones that were

[1] Bot. Gaz. xxxvi. 161–186, 280–302, 349–367, 429–455 (1903).

floating in the fall. The inflorescence is from the end of the long stems and not from the young fresh growth that I collected on May 1." On May 26, the plants were still in flower, but on May 31 the flowers had disappeared. I was unable to ascertain whether the plants fruit freely, but I have no doubt that they do, as I have perfect fruit secured near by, in a mud hole by Fresh Pond in the middle of July, as the plants were beginning to disintegrate.

On July 29, I note the gradual disappearance of the *Potamogeton*. "The Pondweed has gone below the surface for the most part, for I walked a good distance on the river bank and could see but little, and that was just beneath the surface of the water." On August 27, the following note was made, "when I first visited the marsh in the middle of July the broad band of *P. crispus*, that lined the margin of the river a few feet from the bank, was floating just below the surface and was quite visible. The plants are now disappearing and but little can be seen here and there." I think that the mass of floating plants sinks out of sight and remains through the winter at some depth, rising again in spring, the large portion of the plants disintegrating, and fresh shoots on them, that were observed in the spring of the previous year, flowering and continuing the growth.

During September and October, 1912 and 1913, broken, decaying masses of the plant were seen floating here and there along the shore and in the mouths of the ditches.

Potamogeton dimorphus Raf. Several plants in a cove at the south end.

Naias flexilis (Willd.) Rostk. & Schmidt. Very abundant in ditches and off shore.

Triglochin maritima L. Abundant over the marsh.

Sagittaria latifolia Willd. Fairly abundant in a ditch at the south end.

Sagittaria latifolia Willd., forma *obtusa* (Muhl.) Robinson. With the type, also large plants in a ditch at the west end, and mouth of ditch on the east side.

Sagittaria latifolia Willd., forma *hastata* (Pursh) Robinson. A number of plants in a ditch with the type.

Sagittaria latifolia Willd., forma *gracilis* (Pursh) Robinson. A few plants along the river margin.

Alisma Plantago-aquatica L. Finely developed plants at the mouth of a ditch close to the river. Flowering plants, August 16, early state with floating leaves September 12 and October 5.

Digitaria sanguinalis (L.) Scop. Abundant on the west border.

Panicum capillare L. Frequent on the north border.

Panicum dichotomiflorum Michx. Scattered throughout over the areas covered by *Spartina* and *Juncus Gerardi*, extremely abundant in the northern part. When growing on the grass turf the plants are small, but on clear soil they reach a great size, one plant which I measured being ten feet in diameter and rising at the ends of the culms to the height of five feet.

Echinochloa crusgalli (L.) Beauv. Occasional throughout.

Echinochloa muricata (Michx.) Fernald. (Rhodora xvii. 105–107, 1915.) A single plant on the extreme west border; probably occasional throughout.

Setaria glauca (L.) Beauv. Some on the west border.

Zizania palustris L. Several plants, eight feet tall, in a ditch at the south end.

Leersia oryzoides (L.) Sw. Large clump, north end, and abundant in ditches, south end.

Phalaris arundinacea L. Clump several feet in diameter between center and river.

Hierochloë odorata (L.) Wahlenb. A patch some fifteen feet across on the west border.

Phleum pratense L. A number of plants on the west border.

Agrostis alba L. Scattered over the area.

Agrostis alba L., var. *vulgaris* (With.) Thurb. Occasional.

Agrostis alba L., var. *maritima* (Lam.) G. F. W. Mey. Abundant over a small area at the north end.

Agrostis hyemalis (Walt.) B S P. Scattered patches.

Avena sativa L. Several plants on the west border.

Spartina Michauxiana Hitchc. Not uncommon in the northern and central portions growing on the marsh, and occasional on the borders of ditches.

Spartina glabra Muhl., var. *pilosa* Merr. By a ditch at the north end with var. *alterniflora*, scarce.

Spartina glabra Muhl., var. *alterniflora* (Loisel.) Merr. Frequent by a ditch at the north end.

Spartina patens (Ait.) Muhl. Abundant over the area especially in the northern part, covering probably a quarter of the marsh. I will cite my note of September 28, 1912, "Whereas a few stretches of marsh in the northern section, covered with *Spartina patens* and its

var. *juncea*, or *Juncus Gerardi* are practically or quite free from other vegetation, the great bulk of the areas over the marsh are covered with various species of other plants invading the areas formerly devoted to the two species above mentioned. These two species still cover most of the area, but they are quite obscured when the invading growth is in full bloom."

Spartina patens (Ait.) Muhl., var. *juncea* (Michx.) Hitchc. With the species, rather sparingly, in the northern half, but not in mats.

Distichlis spicata (L.) Greene. In considerable abundance at the north end on the marsh, and abundant on the marsh and in ditches on the west side.

Poa annua L. Several plants in soft mud in a ditch in the southern half.

Poa triflora Gilib. Frequent.

Poa pratensis L. Scattered throughout, especially abundant on the eastern border along the river.

Glyceria septentrionalis Hitchc. Abundant in ditches and wet ground throughout, especially on the west side, one plant growing on the marsh away from water.

Puccinellia maritima (Huds.) Parl. Scattered over the marsh in isolated patches. A specimen is in my herbarium collected here on June 26, 1884. My journal records it as "abundant by the river" then.

Festuca ovina L. Occasional in dense tufts on the west border.

Festuca elatior L. One large clump, wet soil, west border.

Agropyron repens (L.) Beauv. Densely covering a considerable area in the southern portion, and scattered throughout.

Cyperus ferax Richard. Abundant at the north end and occasional at the south end. While preferring the borders of the ditches and river, it also grows on the marsh.

Scirpus americanus Pers. On west border, abundant by a ditch and scattered plants amongst *Juncus Gerardi*.

Scirpus robustus Pursh. Abundant in wet ground at the south end, where plants are 5 feet in height; occurring also by a ditch on the west border.

Scirpus campestris Britton, var. *paludosus* (A. Nelson) Fernald. Abundant by a ditch on the west side. I have a specimen in my herbarium collected here June 26, 1884.

Carex scoparia Schkuhr. Several clumps on the west border, and a few plants by the river, the latter a starved form.

Carex tribuloides Wahlenb. Borders of the river.

Carex hormathodes Fernald. Abundant at the north end by the river, and on the west border; occurring sparingly at the south end.

Carex hormathodes Fernald, var. *invisa* (W. Boott) Fernald. Margin of the river, north bank.

Carex vulpinoidea Michx. Several clumps scattered along the river and inland borders of the marsh.

Carex stipata Muhl. Several clumps along the border of a ditch on the west side.

Lemna minor L. Abundant along the river border at the north end and in ditches at the south end.

Pontederia cordata L. A single plant in the river near the shore at the north end, and another in similar situation at the south end.

Juncus Gerardi Loisel. The Black Grass still occupies a large area of the vegetation and covers, certainly, half of the marsh. It occurs in large, scattered, compact areas. See note under *Spartina patens*.

The Black Grass here grows to the height of 15 inches and then lies prostrate. I had noticed that in the latter part of July some of the areas had been mowed down, while in other areas it was lying flat. I was puzzled till one day I saw a man resting near by with scythe beside him, and from him I learned the story. The owners of Coolidge Farm very close to the marsh, cut all the *Juncus Gerardi*, and use it for packing on their celery beds in the fall to keep the stocks from freezing during the winter. The best time to cut the *Juncus* for this purpose is after the plants have dried up, when they lie prostrate. Of course, they are harder to cut at that time. This solved the mystery. The cutting is done between the middle of July and the middle of August.

Juncus tenuis Willd. On the river bank close to the water, where sometimes abundant, and in the middle of the marsh.

Juncus acuminatus Michx. Occasional in the northern portion.

Asparagus officinalis L. Two plants at the southern end.

Salix babylonica L. Three shrubs, one, sterile, by a ditch in the northern portion, and two male and female, 7 to 9 feet in height, near together by a ditch in the western portion.

Populus tremuloides Michx. Several small trees in the northern portion, the largest 2.5 inches in diameter, 2.5 feet up.

Populus grandidentata Michx. A single tree some 10 to 15 feet high on the west border.

Betula populifolia Marsh. The Gray Birch grows abundantly over

the entire marsh, especially along the borders of the ditches and the river, but it is springing up more and more on the grassy areas and I noted on September 7, 1913, that the trees had increased in size perceptibly since the year before.

Rumex crispus L. Scattered freely over the entire area.

Rumex Acetosella L. Frequent throughout, especially on the areas that have been mowed. Dense patches on the west side from 15 to 20 feet across.

Polygonum exsertum Small. Sparingly near the border of the marsh.

Polygonum prolificum (Small) Robinson. Abundant in the northern portion.

Polygonum ramosissimum Michx., forma *atlanticum* Robinson. Abundant in the southern section along one of the ditches, also in damp ground on the west side, plants reaching the height of 43 inches.

Polygonum lapathifolium L. Scattered over the extreme northern section, abundant in the northwestern corner.

Polygonum pennsylvanicum L. Very abundant over the northern third of the marsh and along the west side; scattered throughout. Plants collected with pure white flowers.

Polygonum Hydropiper L. Sparingly scattered throughout in wet places; a vigorous plant midway on the river bank.

Polygonum acre HBK., var. *leptostachyum* Meisn. Many plants at the north end, some of them in 6 inches of water in the river.

Polygonum Persicaria L. A dozen or more plants scattered over the area.

Polygonum sagittatum L. Single plant, river border, midway.

Chenopodium album L. Occasional; a flourishing plant in the middle of the marsh.

Atriplex patula L., var. *hastata* (L.) Gray. Scattered over the marsh in dense masses; frequent on the borders of ditches and in areas of *Juncus Gerardi.*

Salicornia europaea L. One patch, about a foot across, of some two dozen plants in a ditch in the middle of the marsh.

Suaeda linearis (Ell.) Moq. An area several feet across covered with this species on the river bank about midway north and south, and a similar area on the west border.

Acnida cannabina L. Abundant on the border of a ditch on the west side.

Spergularia salina J. & C. Presl. (Rhodora xii. 162, 1910.) Scattered abundantly throughout.

Cerastium vulgatum L. Occasional at the north end. On June 17, 1913, I visited several dense patches in fruit on the west border, some distance within the marsh. Each patch was about 10×50 feet in dimensions. I took a single plant and counted from the single root 58 stems, the outside ones $19\frac{1}{2}$ inches long by measurement. This is but one instance of the vigorous growth of weeds on the marsh.

Lychnis dioica L. Several vigorous male plants in the northwest corner.

[*Ranunculus Cymbalaria* Pursh. I have not succeeded in detecting this species which formerly grew here. I have a specimen which I collected on this marsh on June 26, 1884. My journal for this date reads, "I saw only a few plants by a creek which is quite filled at high tide." This species has doubtless disappeared.]

Ranunculus sceleratus L. Several vigorous plants in a ditch, at the northern end.

Lepidium virginicum L. Very abundant throughout, especially near the river border, and forming dense patches with *Juncus Gerardi*, plants very large.

Capsella Bursa-pastoris (L.) Medic. A single plant in the middle of the marsh.

Radicula palustris (L.) Moench. Two plants only, one on the middle of the marsh, and one on the river bank, midway.

Radicula palustris (L.) Moench, var. *hispida* (Desv.) Robinson. A single plant by the river.

Barbarea vulgaris R. Br., var. *longisiliquosa* Carion. (Rhodora xi. 139. 1909.) A large clump on the west border, fruiting profusely.

Potentilla monspeliensis L. Occasional throughout, springing up especially on the mown areas.

Potentilla pacifica Howell. (Rhodora xi. 48, 1909.) Very abundant along the river and ditches and also springing up freely on the marsh away from these borders. I have a specimen collected by me on this marsh on June 26, 1884, with the note from my journal of the same date, "Abundant in the salt-marsh."

Rosa rugosa Thunb. Native of northern China, Corea and Japan. A thrifty shrub 3 feet high near the north end.

Trifolium pratense L. Rather abundant on the west side, and occasional on the mown areas.

Trifolium hybridum L. Occasional, especially on the west border.

Melilotus alba Desr. A single plant on the west side.

Ailanthus glandulosa Desf. A young tree, 5 or 6 feet high, near the center of the marsh in the southern half.

Rhus typhina L. A single small plant directly on the marsh in the northern part.

Impatiens biflora Walt. Abundant on the west side on the borders of a ditch. A single vigorous plant was growing out on the marsh at the south end.

Viola lanceolata L. A few plants on the borders of a ditch at the south end, and a clump about 18 inches across by a ditch on the west side.

Epilobium angustifolium L. A few low plants in the center of the marsh, and scattered throughout.

Epilobium coloratum Muhl. Frequent over the marsh, abundant at the south end.

Epilobium adenocaulon Haussk. Very abundant in the south end.

Oenothera muricata L. Occasional on the river border, and frequent elsewhere.

Oenothera biennis L. Scattered along the east side near the river bank.

Cicuta bulbifera L. Frequent along the river bank and ditches.

Sium cicutaefolium Schrank. A single plant in a ditch at the south end.

Limonium carolinianum (Walt.) Britton. A few scattered plants along the river bank, and by ditches throughout.

Asclepias incarnata L., var. *pulchra* (Ehrh.) Pers. Several plants on the border of the river in the water, and by a ditch on the west side.

Cuscuta Gronovii Willd. Abundant at scattered stations along the river bank and elsewhere, twining over *Aster novae-belgii* and other plants.

Verbena hastata L. A number of plants at the south end in wet ground.

Lycopus americanus Muhl. Abundant throughout, especially along the river bank.

Mentha arvensis L. Three or four plants together near the river bank midway.

Solanum Dulcamara L. Abundant in one spot on the west side.

Linaria vulgaris Hill. Frequent throughout in dense patches.

Linaria canadensis (L.) Dumont. Abundant throughout, the plants remarkably vigorous and large. I will quote from my journal of August 27, 1912, "It is interesting to see the conduct of some of the invading plants. They behave as many species have done and are still doing, when introduced into a new region, taking possession without resistance and densely covering large tracts in profuse abundance. *Lactuca scariola*, var. *integrata*, *Erechtites hieracifolia*, *Linaria canadensis* are illustrative. These plants grow over the marshes, that were once covered by high tides, in the greatest profusion. It is strange to see *Linaria canadensis* so thickly growing. I saw in one place, to-day, a large patch, a few rods across, that had been cut down, and that would make, if stacked, a good-sized cock."

Veronica peregrina L. A single plant on the west side.

Plantago major L. Occasional in scattered localities.

Plantago decipiens Barneoud. Scattered over the marsh, forming colonies.

Sambucus canadensis L. Several vigorous plants on the west side, 5 to 6 feet high.

Eupatorium purpureum L., var. *maculatum* (L.) Darl. A single large plant not far from the center of the marsh.

Solidago sempervirens L. Abundant at the north end, and scattered throughout.

Solidago rugosa Mill., var. *aspera* (Ait.) Fernald. (Rhodora xvii. 7, 1915). Several plants at the north end.

Solidago canadensis L. Sparingly near the center and at the north end.

Solidago altissima L. Several plants in the north section.

Solidago graminifolia (L.) Salisb. Several plants in two localities in the northern half.

Aster vimineus Lam. A number of plants scattered over the marsh.

Aster lateriflorus (L.) Britton. A single large plant in the middle of the marsh.

Aster novi-belgii L. Scattered plants throughout.

Aster subulatus Michx. Abundant throughout, especially on the borders of the ditches. It reaches the height of 4 feet.

Erigeron canadensis L. Scattered over the densely compact grassy areas, including Black Grass, *Juncus Gerardi*.

Baccharis halimifolia L. Well developed staminate and pistillate shrubs, some $4\frac{1}{2}$ feet high, are growing at the north and south ends

and along the river border. The plants are vigorous and form fruit freely. These shrubs, undoubtedly, came from seed from the cultivated plants growing along the border of Mt. Auburn Street, one third of a mile and more away. The akenes, furnished with long and copious pappus, are readily borne by the wind.

Pluchea camphorata (L.) DC. A good many plants in the southern half, in the middle of the marsh and along ditches. Well developed fruit was formed.

Anaphalis margaritacea (L.) B. & H. A few plants on the western portion.

Gnaphalium polycephalum Michx. Very abundant and vigorous over the densely compact grassy areas, including Black Grass, as well as in more open soil.

Ambrosia artemisiifolia L. Frequent on the west border.

Xanthium echinatum Murr. Several fruiting plants at the north end.

Helianthus laetiflorus Pers. Several flowering plants and about two dozen young plants at the south end.

Bidens discoidea (T. & G.) Britton. One or two plants, border of ditch, near the river about midway on the marsh.

Bidens frondosa L. Abundant at mouths of ditches and along the river bank; extremely abundant on the west side; plants vigorous.

Bidens connata Muhl. (Rhodora x. 197–200, 1908.) Scattered here and there over the marsh, a few very large plants about midway on the border of a ditch near the river.

Bidens cernua L. Scattered throughout along the river bank and elsewhere.

Achillea Millefolium L. Occasional.

Tanacetum vulgare L. Several plants at the south end and a few scattered throughout.

Artemisia vulgaris L. Abundant along the marsh border.

Erechtites hieracifolia (L.) Raf. "I noted this from the side of the cemetery and I should say that it covered half of the southern half of the area, besides being extremely abundant in close patches, in the northern half. Also scattered here and there." Journal, Aug. 31, 1912. "Is rapidly discharging its fruit, and, as I walked through the dense areas occupied by this plant, the surface of the marsh was snow-white with the fallen pappus." Journal, Sept. 25, 1912. The dense growth of this plant has nearly killed out the Black Grass,

grasses and low plants in the areas that it covers. See note under *Linaria canadensis*.

Cirsium lanceolatum (L.) Hill. A few vigorous plants scattered over the area.

Cirsium arvense (L.) Scop. Several plants in the center of the marsh on the border of a ditch.

Cichorium Intybus L. Occasional throughout.

Leontodon autumnalis L. Occasional throughout, especially where the *Juncus Gerardi* has been cut. "A very vigorous plant, or two or three plants matted together, on the marsh at the south end. The scapes, which spread out along the ground in a circle and rose erect in the center, were 2 feet, 9½ inches long. The plant was in full flower." Journal, Sept. 7, 1913.

Taraxacum officinale Weber. Extremely abundant over the entire area, growing freely over the beds of *Juncus Gerardi* and elsewhere. "I observed two plants on the marsh at the south end. They were enormous. The one from which I took leaves and stems was 30 inches in diameter, the scapes were 2 feet high, and the plant was a solid mass of leaves." Journal, Aug. 31, 1912.

Sonchus arvensis L. Several stations over the marsh, one large area at the south end, and a vigorous flowering patch by the river about midway north and south.

Sonchus oleraceus L. Abundant throughout, over the densely compact grassy areas as well as in more open soil. In many cases the auricles of the clasping base of the leaves were *rounded* but the akenes were invariably *wrinkled transversely*.

Lactuca scariola L., var. *integrata* Gren. & Godr. Especially abundant in the southern portion, growing densely and very tall and vigorous. I measured one plant, 6 feet, 10 inches high, and it stood up but little above the rest. The dense growth of this species has pretty well killed out the grasses and low growth in the areas occupied by it. See note under *Linaria canadensis*.

Lactuca canadensis L. Occasional throughout.

The plants enumerated above are in my herbarium. In the verification of a number of forms I have been assisted at the Gray Herbarium. The following short list includes species that I collected and verified but did not preserve, as at the time I was not intending to carry out this work.

Anthoxanthum odoratum L. 1912, July 19. A single plant in the middle of the marsh.

Poa compressa L. 1912, July 17. A single plant.

Secale cereale L. 1912, July 17. A single plant in the middle of the marsh; July 19, a few plants.

Hordeum jubatum L. 1912, July 19. A plant in the middle of the marsh.

Rosa virginiana Mill. 1912, July 17. One small plant on the shore.

Hypericum boreale (Britton) Bicknell. 1912, July 19. A number of plants together by the river.

Cicuta maculata L. 1912, July 19. A single vigorous plant by a ditch.

Gerardia maritima Raf. 1912, Aug. 16. A single plant on the marsh. I have in my herbarium specimens of this species which I collected on this salt marsh, Oct. 5, 1890.

Bidens connata Muhl., var. *petiolata* (Nutt.) Farwell. (Rhodora x. 197–200, 1908.) 1912, July 17. One plant on the river bank.

The plants in the above list that occur on salt marshes either habitually or at least very frequently are as follows:

Potamogeton crispus
Triglochin maritima
Hierochloë odorata
Agrostis alba, var. *maritima*
Spartina glabra, var. *pilosa*
" " " *alterniflora*
" *patens*
" " var. *juncea*
Distichlis spicata
Puccinellia maritima
Hordeum jubatum
Scirpus americanus
" *robustus*
" *campestris, var. paludosus*
Carex hormathodes
" " var. *invisa*
Juncus Gerardi
Polygonum exsertum
" *prolificum*
" *ramosissimum*, forma *atlanticum*
Atriplex patula, var. *hastata*
Salicornia europaea
Suaeda linearis
Acnida cannabina
Spergularia salina
Potentilla pacifica
Limonium carolinianum
Gerardia maritima
Plantago decipiens
Solidago sempervirens
Aster novi-belgii
" *subulatus*
Baccharis halimifolia

Summary.

Total number of species, varieties and forms observed on the marsh 164
Plants generally affecting saline habitats . . 34
Plants which have appeared since the reclamation began 130

From these figures it will be seen that the plants of saline habit constitute a little over 20 per cent and the invaders something above 79 per cent of the vegetation as reconstituted. It may be of interest to note that more than half of the present vegetation of the marsh belongs to four families, while the remainder belongs to many scattered families, the figures being as follows:

Gramineae . . . . . 20+ per cent
Cyperaceae . . . . . 6+ " "
Polygonaceae . . . . . 6+ " "
Compositae . . . . . 21+ " "
All the other families . . . . . 45 " "

Cambridge, Massachusetts.

THE IDENTITY OF CIRCAEA LATIFOLIA AND THE ASIATIC C. QUADRISULCATA.

M. L. Fernald.

The common Enchanter's Nightshade of dryish woods in the eastern United States and southeastern Canada is generally treated as identical with *Circaea lutetiana* L. of Europe. Yet a comparison of the two plants as well as of accurate descriptions and plates shows that they differ in many important characters.

Typical *Circaea lutetiana* of Europe has the stems closely pubescent throughout; the stolons thick and almost tuber-like; the leaves broadly ovate; the petals broadly obovate, longer than broad and obtuse to rounded at base; and the mature fruit without corruga-

tions. The American plant which passes as *C. lutetiana* has, on the other hand, the stems glabrous below the inflorescence or at most remotely pubescent; the stolons filiform; the leaves oblong-ovate; the petals broadly obovate, as long as or longer than broad and wedge-shaped at base; and the mature fruit with 3–5 corrugations on each face and larger than in the European plant. Differing in all these characters and geographically quite isolated, it is apparent that the American plant should not be confused with *C. lutetiana.*

That the two were not identical was apparently recognized by the older botanists, for as early as 1700 Tournefort had a "*Circaea Canadensis, latifolia, flore albo,*" [1] which formed the basis of the Linnean *C. lutetiana, β. canadensis.*[2] This plant referred by Linnaeus, as a variety, to *C. lutetiana* was not further defined by him and, in view of the comparatively narrow leaf of the American plant, the Tournefortian description, "latifolia," copied by Linnaeus, forms an unfortunate basis for separation. Yet our American plant was long known as var. *canadensis,*— by Michaux, Pursh, Nuttall, Torrey and others. Even as early as 1756, however, John Hill had taken up the Tournefortian *Circaea canadensis, latifolia, flore albo* of North America as *C. latifolia* [3] which he described at length, with the leaves "broad and oblong," as opposed to "oval" in his description of *C. lutetiana* and "broad and short" in his *C. minima* (*C. alpina*), and the "seed-vessel. . . . large" as contrasted with "seed-vessels. . . . small" in *C. lutetiana.* By these two essential characters, oblong leaves and larger fruits, Hill was clearly describing the American representative of *C. lutetiana,* as he was when he emphasized the tall plant by stating that "The stalk is round, upright, firm, hairy, and two feet high," although the character "hairy" appears only at the summit of the stem, along the axis of the inflorescence. To be sure, the name *C. latifolia* found no recognition in *Index Kewensis*; but there is hardly a question that our American representative of *C. lutetiana* should be called *C. latifolia* Hill.

In studying the Old World species of *Circaea* a characteristic plant of eastern Asia,—Manchuria, Amur, and Japan — has been found which, in aspect as well as in all the technical characters of glabrous stem, outline of leaf, shape of petal and corrugation of fruit, exactly

[1] Tourn. Inst. i. 301 (1700).
[2] L. Sp. Pl. i. 9 (1753).
[3] Hill, Brit. Herb. 138 (1756).

coincides with the common Alleghanian plant. No stolons of the Asiatic plant have been examined but so accurately does it coincide with our plant in all the other crucial points that there can be hardly a question of their identity. The Asiatic species which seems clearly to agree with ours is *C. quadrisulcata* (Maxim.) Franchet & Savatier,[1] based upon *C. lutetiana,* var. *quadrisulcata* Maximowicz,[2] a plant originally described from Amur and distinguished by its 4-sulcate fruit, its glabrous stem, and its lance-ovate leaves. The identification of this plant of eastern Asia with our Alleghanian woodland species is interesting as adding still another to the large group of genera and species — *Caulophyllum, Podophyllum, Liriodendron, Polygonum virginianum,* etc.— which are common to these two isolated areas.

Gray Herbarium.

WEED GROWTH AND UNUSUAL RAINFALL.

J. Y. Bergen.

The unusual rainfall throughout the central and northeastern states during the summer just past has greatly influenced most kinds of vegetation. In the course of a long-continued, hand to hand contest with weeds in a garden of moderate size the writer was led to note some differences between the relative abundance and luxuriance of growth of certain weeds this year and in ordinary summers. The rainfall in and near Boston during July of this summer (1915), 8.85 inches, has been equaled only twice in 98 years, the July average for that whole period being about 3.57 inches.[3] The August rainfall this summer is 5.63 inches, while the 98-year average for the month is about 4.01 inches, making the rainfall for the two months almost double the usual amount. Farther away from the coast the precipitation has in many localities been much in excess of the values for Boston just cited.

[1] Franch. & Sav. Enum. Pl. Jap. i. 169 (1875).

[2] Maxim. Prim. Fl. Amur. 106 (1859).

[3] 1818–1870 observations at Roxbury; 1871–1915 observations of U. S. Weather Bureau in Boston.

Herbaceous vegetation in general has grown more vigorously than usual in consequence of the abundant water supply. A few examples from a grassy vacant lot in Cambridge, with very poor sandy soil, may suffice to illustrate this. *Ambrosia artemisiifolia* showed plenty of specimens growing to a height of 1.5 metres; *Oenothera biennis* reached a height of 1.72 metres; *Erechtites hieracifolia* (a moisture-loving plant which does not usually grow at all in this bit of ground) was 2.0 metres high. *Helianthus grosseserratus*, growing in tough sod near by, reached a height of 3.3 metres. The annual weeds of the field and garden are perhaps rather more sensitive in their responses to variations in their environment than most seed plants. Competition is especially sharp among these species and they have no such monopoly of their seed beds as do many plants which grow in uncultivated soil. Most of the species which the agriculturist reckons as weeds are mesophytes, but the range in water requirement between such a plant as the ox eye daisy, *Chrysanthemum Leucanthemum*, var. *pinnatifidum* and such a one as the great ragweed, *Ambrosia trifida*, is rather wide.

For convenience some of the common weeds of New England in regard to which the writer has been able to obtain notes this summer may be arranged in three groups:

1. Those which are decidedly more vigorous than usual.
2. Those which show little difference in growth from that of ordinary seasons.
3. Those which are relatively less important than in ordinary seasons.

Prominent among the first group are the coarse annual grasses, finger grass, *Digitaria humifusa*, crab grass, *Digitaria sanguinalis*, barn yard grass, *Echinochloa crusgalli*, and old witch grass, *Panicum capillare*. These are all shallow-rooted species, with large and probably actively transpiring leaf surfaces. The only common representative of *Cyperaceae* is the rather abundant, very variable, tuber-bearing *Cyperus strigosus*. Other weeds much in evidence this season are lady's thumb, *Polygonum Persicaria*, horseweed, *Erigeron canadensis*, ragweed, *Ambrosia artemisiifolia*, and beggar ticks, *Bidens frondosa*. All these weeds, though they are troublesome in ordinary soils and every year, flourish best when they can get an abundant supply of moisture.

The weeds which the writer has found to be not much more conspicuous and annoying this year than usual are many of them among the

most pestilent to be found in New England fields and gardens. Prominent among these are couch grass, *Agropyron repens*, green foxtail, *Setaria viridis*, common sorrel, *Rumex Acetosella*, pigweed, *Chenopodium album*, rough pigweed, *Amaranthus retroflexus*, and lady's sorrel, *Oxalis corniculata*. The *Agropyron* roots deeply and can always secure water, even from rather dry soils, through its wide-ranging, many-rooted rhizomes. The *Rumex* has an exceedingly extensive and intricate root system. It is not so easy to explain why the other four species named in this group seem to be so little affected by the presence, or absence of an abundant water supply.

The only weeds which have seemed to me relatively less important this season than usual are carpet weed, *Mollugo verticillata* and purslane, *Portulaca oleracea*. Both are xerophytes, as is evident from the way in which they tolerate extreme drought conditions, the former growing on very dry sand dunes, the latter a common weed in some of the driest parts of eastern Kansas and capable in ordinary climates of growing long after it has been uprooted and left lying on the surface of the soil. The seeds of purslane, according to Professor G. E. Stone of the Massachusetts Agricultural college, are exceptional in their power to grow in very dry soil, germinating in earth containing only 0.5 per cent of moisture. It would not be easy to show marked xerophytic features in the form or the structure of *Mollugo*, but *P. oleracea* is decidedly succulent and is the most familiar plant of this type throughout a large portion of the central and the northeastern states.

Doubtless other observers may in many cases have found different weed species predominant this year from those that have come under my own notice. Professor M. A. Chrysler of the University of Maine, at Orono, Maine, reports the July rainfall this year as 6.67 inches, while the average rainfall for the month is 3.22 inches. He does not report any weeds as having been unusually common. Mr. H. E. Downer reports from the botanic garden of Smith College, at Northampton Mass., that almost all weeds are more troublesome than usual this season and names *Digitaria sanguinalis*, *Mollugo verticillata*, *Portulaca oleracea*, *Oxalis corniculata*, *Acalypha virginica*, *Convolvulus arvensis*, and *Ambrosia artemisiifolia* as particularly abundant.

Weeds of lawns and grass lands, as a rule, have shown less response to the stimulus of an unusual rainfall than have many of the denizens of tilled ground. This may be partly because the grasses among

which they grow have taken up much of the water. But other reasons, in the cases of such deep-rooted composites as *Taraxacum, Cichorium,* and *Leontodon* may be found in the facts that their roots reach well down into the soil after water and that their latex supply appears to hinder excessive transpiration, so that they are more independent of an abundant water supply than are most leafy, non-succulent plants.

Along the borders of sidewalks and in the stone-paved gutters of Cambridge streets there is found a limited flora, consisting largely of small and somewhat xerophytic plants, among which are a few grasses, such as *Eragrostis capillaris, Eragrostis Frankii, Poa annua,* and a few other species, which do not usually either flower or fruit. Other plants of frequent occurrence are, *Polygonum aviculare, Mollugo verticillata, Spergularia rubra, Euphorbia maculata, Euphorbia humistrata,* and *Gnaphalium uliginosum,* all small-leaved plants of little capacity for transpiration. Depauperate specimens of *Plantago Rugelii* are also abundant. The members of this sidewalk flora are for the most part no more conspicuous than usual this summer, though perhaps the grasses have fruited more successfully than they generally do.

Summing up my own observations in the briefest terms, it may be said that many of our annual weeds and ruderal plants have profited greatly by the unusual water supply which they have received this summer and that in general, but not always, more than ordinary luxuriance has characterized those species which would *a priori* have been classed as large consumers of soil water.

CAMBRIDGE, MASSACHUSETTS.

EXTENSIONS OF RANGE.— During a visit to Monhegan Island on the coast of Maine in the summer of 1911 the writer noticed, while hurrying from "Cathedral Woods" to the wharf to catch the boat to Boothbay, a few specimens of *Carex crinita* which had an unusual appearance. These were hastily gathered and upon later study proved to be *C. crinita,* var. *Porteri* (Olney) Fernald. It was not possible to return for further collections, so no information is at hand as to the distribution or abundance of this rare variety on Monhegan. Its mere occurrence on this oceanic island, lying isolated, twenty miles from the mainland, is sufficiently remarkable and interesting. The variety is based upon specimens collected by Dr. Thomas C. Porter,

near the base of Mt. Kineo, Moosehead Lake, Maine, August 28, 1871, and so far as the writer knows has never been collected since until these Monhegan specimens were found. Some of the latter material has been deposited in the Gray Herbarium, where its identification has been confirmed by Prof. M. L. Fernald.

Digitalis purpurea L. is described in Gray's Manual 7th edition, p. 726, as having in America a very restricted distribution in "Meadows and pastures, Cape Breton I.; also N. Y.; rather rare and local a casual escape from gardens." The writer was accordingly greatly surprised during the summer of 1914 to find it growing in considerable abundance along a sandy roadside south of Glen Orchards near the west shore of Muskoka Lake, Ontario. Inquiry elicited the fact that it had been introduced from England by a settler twenty years ago. It has gradually spread from his farm along roadsides for several miles, and also back into open places in the woods. It seems thoroughly established and naturalized, seeds freely, and is spreading widely. It occurs as separate, scattered individuals rather than in colonies.—Frederick O. Grover, Oberlin College, Oberlin, Ohio.

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